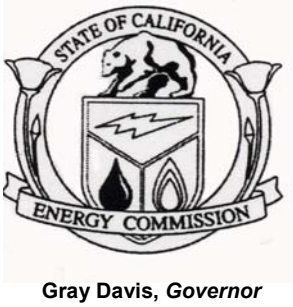
Reducing California's Petroleum Dependence

CALIFORNIA
ENERGY
COMMISSION

CALIFORNIA
AIR RESOURCES
BOARD

STAFF DRAFT REPORT

MAY 2003
P600-03-005



Gray Davis, *Governor*

CALIFORNIA ENERGY COMMISSION

CALIFORNIA AIR RESOURCES BOARD

Susan Brown
Dan Fong
Sherry Stoner
Eileen Tutt
Paul Wuebben
Principal Authors

Susan Brown
Project Manager

Susan Brown
Manager
TRANSPORTATION TECHNOLOGY OFFICE

Scott W. Matthews
Deputy Director
TRANSPORTATION ENERGY DIVISION

Robert L. Therkelsen
Executive Director

Disclaimer

This report was prepared by the staff of the California Energy Commission and the California Air Resources Board. Opinions, conclusions and findings expressed in this report are those of the authors. The report does not represent the official position of the Energy Commission or the Air Resources Board until adopted and approved at a public meeting.

ACKNOWLEDGEMENTS

Energy Commission Contributing Staff

Gerry Bemis
Dan Fong
Melissa Jones
Elizabeth Parkhurst
Mike Smith
Sherry Stoner

Air Resources Board Contributing Staff

Chuck Shulock
Eileen Tutt

Management

Tom Cackette, Chief Deputy Executive Officer, Air Resources Board
Scott W. Matthews, Deputy Director, Transportation Energy Division, Energy Commission
Susan Brown, Manager, Transportation Technology Office, Energy Commission

TABLE OF CONTENTS

Page

LIST OF TABLES AND FIGURES

Page

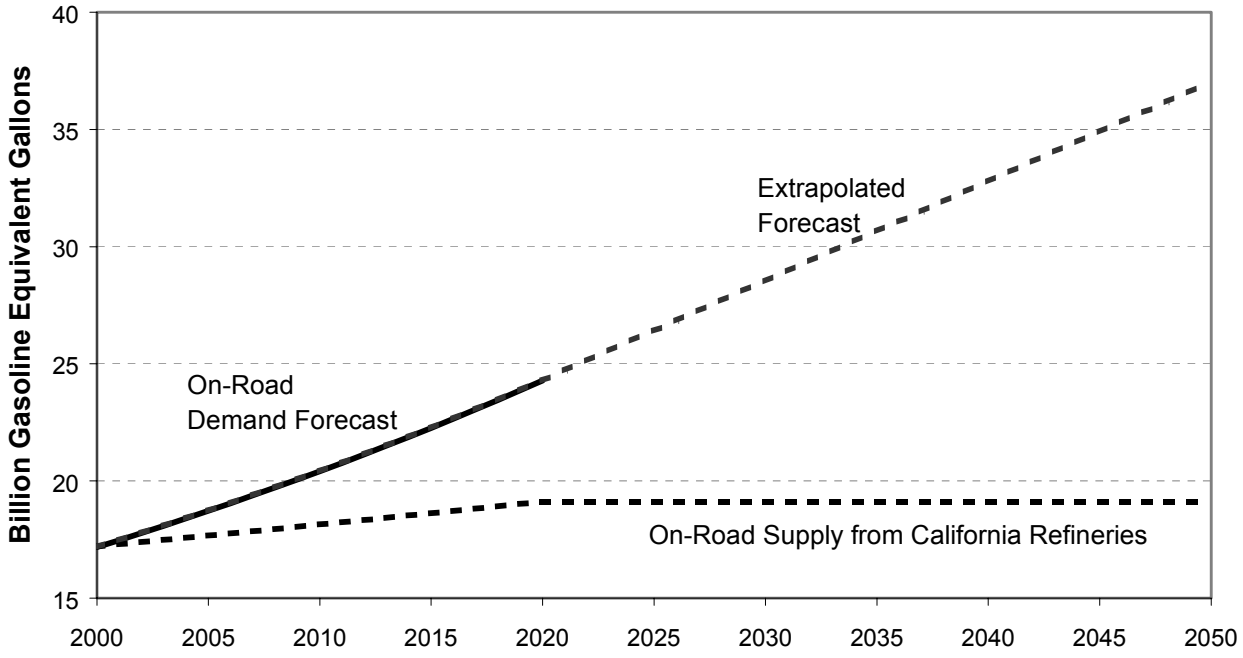
Why Does California Need to Reduce Its Dependence on Petroleum?

California faces a future of increasing petroleum dependence, supply disruptions, and price volatility. At the beginning of this decade, California had a population of 33.8 million people, driving 24 million registered vehicles, and consuming 16.8 billion gallons a year of gasoline and diesel fuel.

The California refining capacity has not been able to keep up with the growing demand for transportation fuels. As a consequence, the state has become a significant importer for all its petroleum products. This, in combination with marine and distribution infrastructure limitations, has made the California gasoline market increasingly unstable. As long as demand for transportation fuels continues to grow, California's gasoline supply will be subject to rapid and frequent price volatility.

Unless we make a major change, by 2020, 45.5 million Californians will have 31.5 million registered vehicles consuming nearly 24.5 billion gallons of gasoline and diesel fuel (see Figure 1). If this consumption occurs, it would require Californians to accept major expansions in petroleum refinery and delivery infrastructure, further dependence on foreign energy supplies, decreased environmental quality, and reductions in public health.

Figure 1
Gasoline and Diesel Demand in California



A vibrant California economy depends on secure, reliable, and affordable sources of transportation fuel. The recent war in Iraq underscores the importance of reducing California's and the nation's growing dependence on unstable foreign oil sources. Although these concerns are long-term, the state must take action now to avoid the adverse consequences of California's growing petroleum dependence.

California faces three major problems from its increasing reliance on petroleum: economic, sources of supply, and environmental.

Economic. Unless consumers are given viable options, California could continue to face significantly higher gasoline and diesel prices. Such options could dampen demand for petroleum and moderate price fluctuations.

Rising petroleum prices can have a significant impact on the U.S. and California economies. In addition to reducing the real income of consumers through higher fuel prices, oil price increases drive up the average cost of production of goods and services throughout the economy. The result is a negative impact on the state's economy (gross state product). In fact, the significant petroleum price hikes in 1973-74, 1979-80, and 1990 all led to U.S. recessions.

Sources of Supply. Historically, California has obtained supplies of petroleum from in-state production, imports from Alaska, and imports from foreign sources. Because in-state production has been declining by about 2 percent per year, however, California will become increasingly reliant on sources outside of the state for petroleum and refined petroleum products.

Currently, Iraq and Saudi Arabia are the two largest sources of foreign imports. If this import trend continues, the state's economy will be even more vulnerable to external disruptions and geopolitical instability. Recent disruptions in foreign petroleum and gasoline supplies have harmed the state's economy and led to peaks in gasoline prices. For example, the loss of oil production from Venezuela earlier this year temporarily caused oil prices to rise, leading to high gasoline prices. In addition, in early 2003, concerns about military conflicts in Iraq also resulted in a spike in world oil prices.

Environmental. Increasing our reliance on petroleum would increase greenhouse gas emissions and be an obstacle to improved air quality. Scientific evidence points to the potential for severe climate change impacts on our ecosystems, economy, and health. For example, early melting of mountain snow packs could lead to water shortages in many parts of California. In addition, storm surges and flooding, combined with rising sea levels, could lead to major impacts on coastal communities, and warming of the earth's atmosphere could exacerbate urban smog.

In general, measures aimed at reducing transportation related petroleum use will reduce California's greenhouse gas emissions. In 1999, California sources emitted 417 million tons of greenhouse gases in carbon dioxide equivalent units. The on-road mobile

source emissions of carbon dioxide, methane, and nitrous oxide were responsible for over half of the total statewide greenhouse gas emissions.

Less use of gasoline reduces smog-forming emissions that occur at each point in the distribution system. Zero-emission vehicles, such as fuel cell vehicles, result in no smog-forming or particulate emissions from the vehicle.

To avoid the adverse consequences of California's dependence on petroleum, the state must adopt measures to improve transportation energy efficiency and expand the use of alternative fuels. Furthermore, supporting the use of alternative fuels should allow for a smooth transition away from petroleum dependence in the transportation sector. There are steps that government can take in the near-term. The most effective strategies to reduce demand for petroleum, however, require long lead times to fully implement. Therefore, urgent focus on these issues is needed now.

Legislative Direction

In response to the public's concerns about price volatility, supply shortages, and the frequency of refinery outages, the California Legislature passed Assembly Bill 2076 in 2000 (AB 2076, Shelley, Chapter 936, Statutes of 2000). This bill directs the California Energy Commission (Energy Commission) and the California Air Resources Board (CARB) to develop and adopt recommendations for the Governor and the Legislature on a California strategy to reduce petroleum dependence.

The statute requires the strategy to include goals for reducing the rate of growth in the demand for petroleum fuels. Options to be considered include increasing transportation energy efficiency and using non-petroleum fuels and advanced transportation technologies including alternative fueled vehicles and hybrid electric vehicles.

In response to this direction, the Energy Commission and the CARB developed a process to evaluate and analyze various demand reduction options. The goal of this effort is to provide policy makers with an objective analysis of the possible measures to reduce California's dependence on petroleum. An important part of the process involved an extensive and comprehensive public review of the analysis. The Energy Commission and the CARB worked together to hold public workshops and meetings with representatives of the oil industry, natural gas industry, the ethanol industry, diesel engine industry, and environmental groups.

This report addresses both near-term and mid- to long-term strategies to reduce the demand for petroleum fuels in California. AB 2076 also requires the Energy Commission to examine the feasibility of a strategic fuels reserve as another near-term option to moderate price volatility in California. The analysis of a strategic fuels reserve and other supply-related options are examined in a separate Energy Commission proceeding. These various studies are located on the Energy Commission's website at [www.energy.ca.gov/fuels/pipeline/ documents/index.html].

Proposing the Solution

In this section, the staff addresses the following questions on reducing the state's dependence on petroleum:

- What options were evaluated?
- What demand reduction goal does the staff recommend?
- What options could be used to meet the goal?

What Options Were Evaluated?

The staff evaluated various demand reduction options and categorized them as fuel efficiency, fuel substitution, pricing, and other options. The staff estimated the reduction in petroleum demand and the direct net benefits for each option. Direct net benefit is defined as the combined costs and benefits associated with each petroleum reduction option. Detailed information on each can be found in *Appendix C: Petroleum Reduction Options (Task 3)*. The costs and benefits of each option include the following:

- Increased costs associated with the purchase and use of new and/or additional technologies.

- Loss of government revenue due to reduced sale of fuel.

- Reductions in the external costs associated with petroleum dependence, including energy security and economic costs.

- Savings associated with reduced operational cost, for example, the savings associated with reduced fuel usage.

- Savings associated with avoided damages from pollution, including health cost savings and avoided damages from climate change pollutants.

The estimated direct net benefits evaluated accrue within the state. The only exceptions are the avoided damages from climate change, which are global benefits, and reduced external costs associated with petroleum dependency, which are national benefits.

Two of the categories, fuel efficiency and fuel substitution, are discussed below.

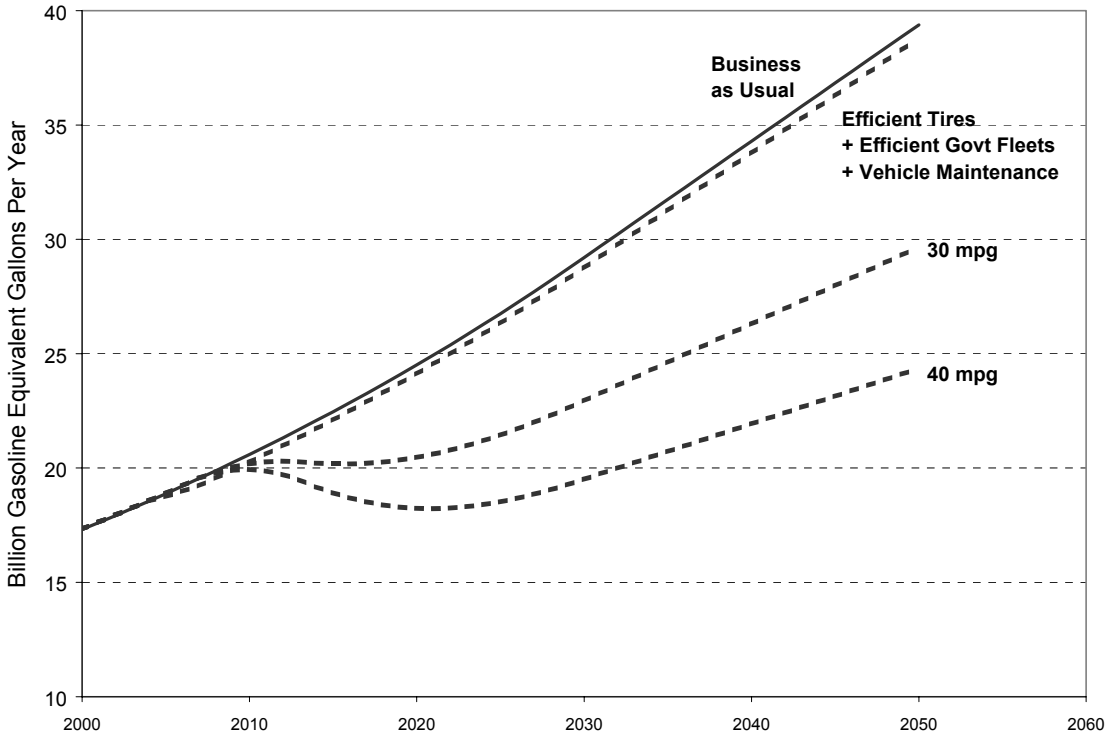
1. Fuel Efficiency Options

   The most dramatic reduction in petroleum demand is achieved by improving vehicle fuel efficiency. The staff evaluated a number of options to improve the fuel efficiency of on-road vehicles, including the following:

- Improved fuel economy of cars and light-duty trucks.
- Improved fuel economy of medium and heavy duty trucks.
- More fuel efficient replacement tires.
- Improved vehicle maintenance.
- Increased purchase by government of fuel efficient vehicles.

Figure 2 illustrates that improving the fuel efficiency of new vehicles would have the greatest effect in reducing petroleum demand. If the fuel economy of new cars and light trucks were improved to 35-45 mpg by the year 2010, the growth in demand for on-road transportation fuels would be reduced to zero by the year 2020, although demand would begin to increase again by 2030.

Figure 2
Demand Reduction of Selected Fuel Efficiency Options

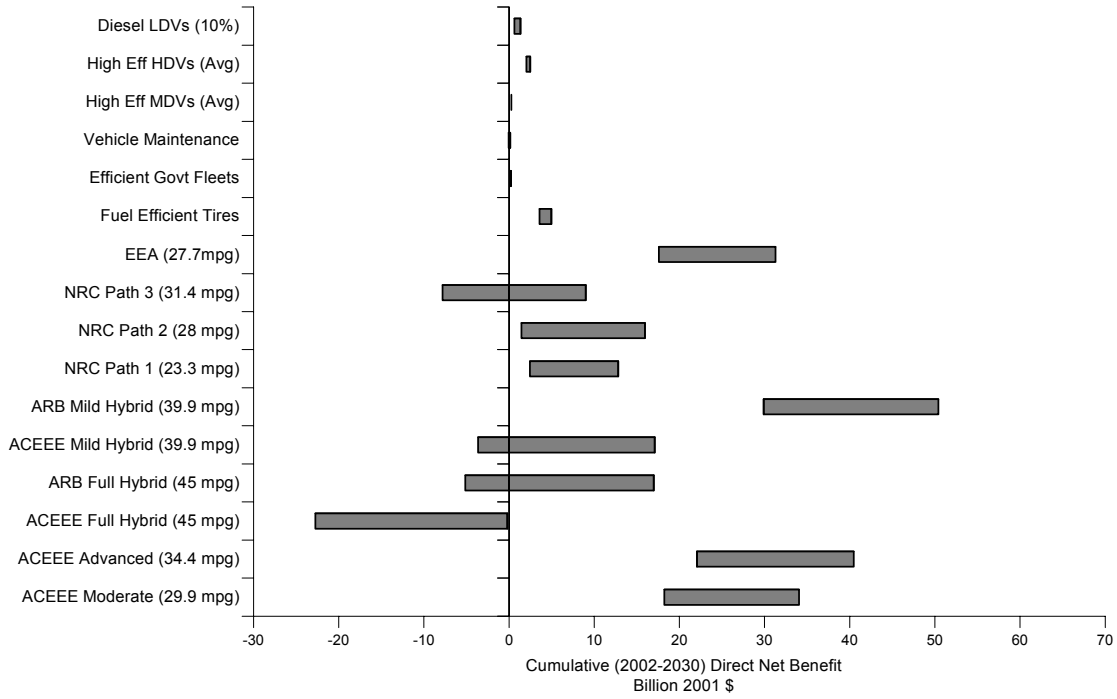


According to reputable national experts, it is technically possible to more than double the efficiency of new cars and light-duty trucks using existing and emerging automotive technologies. These technologies include improvements in engines and transmissions, aerodynamic styling, weight reduction, and increased use of hybrid electric and diesel propulsion systems. Many of the technologies evaluated in this report are being used in one or more vehicles in production today.

Figure 3 illustrates the direct net benefits for selected efficiency options. The width of the bar for each option reflects the range of technology costs and fuel costs assumed (e.g., $1.47 to $1.81 per gallon of gasoline). Positive numbers indicate

direct net benefits, while negative numbers indicate a direct net cost. The fuel efficiency values listed in the figure refer to on-road fuel economy. In this report, the Energy Commission and CARB staff relied on work by the National Research Council (NRC) and American Council for an Energy-Efficient Economy (ACEEE). Two additional options, labeled ARB, involved modifying the costs used in the ACEEE studies to reflect a more aggressive, long-term cost reduction of hybrid electric drive train technology.

Figure 3
Direct Net Benefit of Fuel Efficiency Options



Because nearly all of the fuel efficiency options have a positive direct net benefit, the capital cost of improving fuel efficiency, the increased purchase price of a new car, is more than offset by the lifetime fuel savings. This analysis is sensitive to the estimated future cost of technologies. For more detail, see *Appendix C: Petroleum Reduction Options (Task 3)*.

2. Fuel Substitution Options

Significant reduction in petroleum demand can also be achieved by substituting non-petroleum fuels for gasoline and diesel. The staff evaluated the following alternative fuel options:

- Natural gas used in gasoline and diesel-like engines
- Ethanol blends

- Liquid petroleum gas (LPG)
- Non-petroleum derived diesel fuel (Fischer-Tropsch and biodiesel)
- Electric vehicles
- Hydrogen fuel cell vehicles

For many of the alternative fuels, it is difficult to estimate the degree to which they could substitute for gasoline and diesel. For example, many of the alternative fuels currently lack the necessary infrastructure to support widespread use. In the case of battery electric and fuel cell technology, significant technological improvements and cost reductions are necessary before the vehicles would be widely accepted.

In general, the staff used a penetration rate of 10 percent of new vehicle sales for each type of alternative fuel vehicle, which allowed different alternative fuels to be compared to each other on a cost and benefit basis. Fuel blends are an exception to this analysis. For example, the staff analyzed a diesel fuel blend of 33 percent Fischer-Tropsch diesel and 67 percent conventional diesel, also evaluating gasoline blends containing higher percentages of up to 85 percent ethanol as a fuel option for flexible fuel vehicles.

Figure 4 shows the demand reduction for selected fuel substitution options. Using Fischer-Tropsch diesel made from natural gas in heavy-duty vehicles as a 33 percent blend would reduce the state's total petroleum demand about 6 percent. Furthermore, replacing 10 percent of new light-duty gasoline vehicle sales with hydrogen fuel cell vehicles would reduce overall petroleum demand about 8 percent. To illustrate the potential for greater petroleum displacement, increasing hydrogen fuel cell penetration to replace 20 percent of new light-duty gasoline vehicle sales would reduce overall petroleum demand by about 15 percent.

The staff evaluated each of the fuel substitution options for its direct net benefit. The results are shown in Figure 5. Most of the alternative fuel vehicle options have a direct net cost, in contrast to the net benefit of many of the fuel efficiency options. Fischer-Tropsch diesel blend is the only fuel substitution option that has a positive direct net benefit at today's fuel prices.

The negative direct net benefit of the other alternative fuels and vehicles is largely a result of the higher fuel costs compared to the projected price for gasoline and diesel ($1.64 per gallon). If the price of gasoline and diesel should rise and be sustained to the $2.00 to $2.50 per gallon range, however, the analysis shows that most of the alternatives would have positive net societal benefits, assuming the price of the alternative fuel did not rise concurrently.

Figure 4
Illustrative Demand Reductions for
Selected Fuel Substitution Options

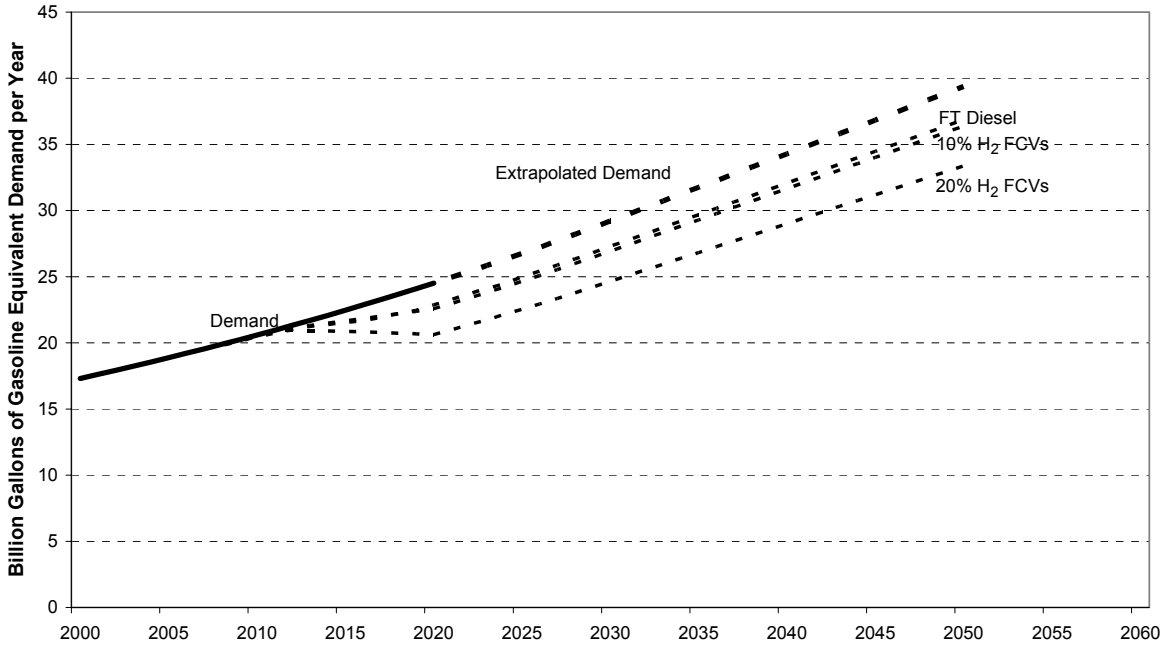
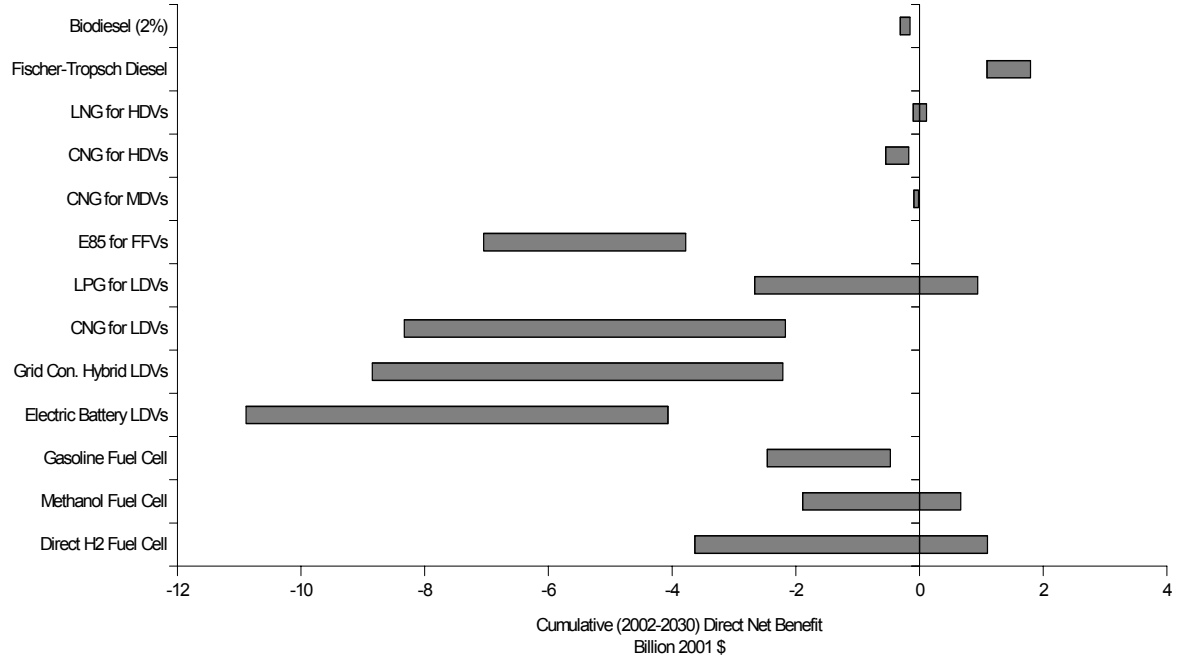


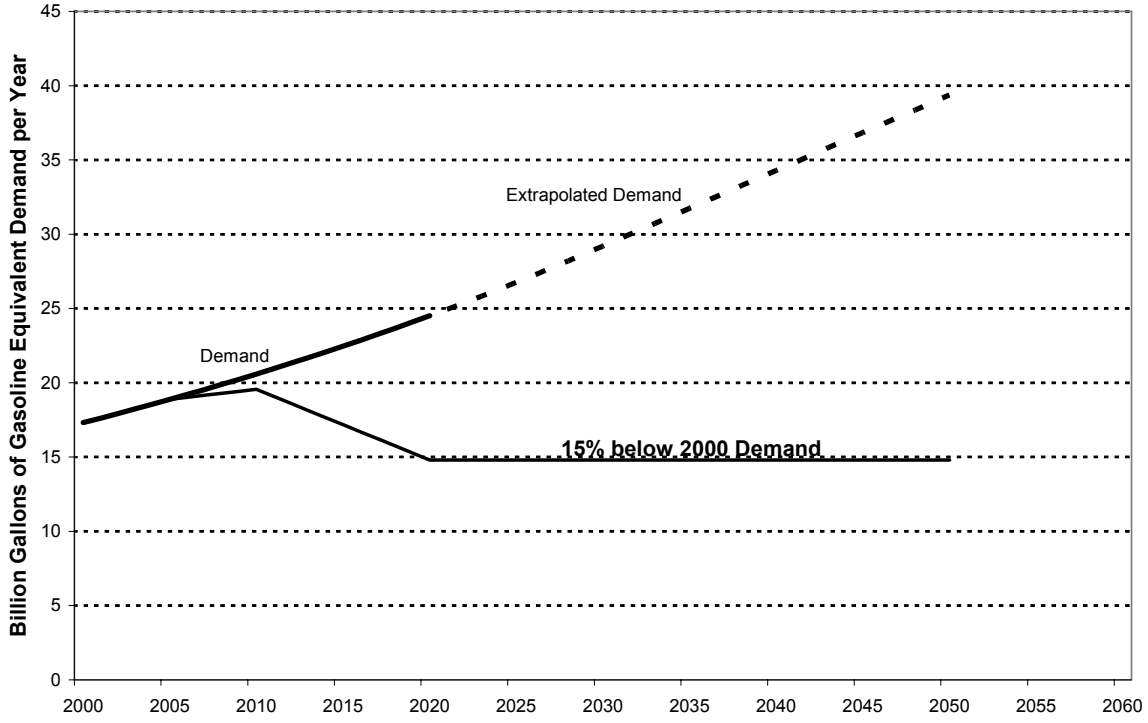
Figure 5
Direct Net Benefit of Fuel Substitution Options



What Petroleum Reduction Goal Does the Staff Recommend?

The staff evaluated California's increasing demand for petroleum fuels, and the options that are feasible and economical to reduce demand. As directed by statute, and based on the analysis in this report, the staff recommends that California adopt a policy to reduce gasoline and diesel fuels demand by 2020 to 15 percent below 2000 demand levels. Figure 6 Illustrates this goal.

Figure 6
Recommended Petroleum Reduction Goal



This goal is aimed at keeping California's transportation sector, and the broader economy which depends on it, vibrant, competitive, and environmentally sustainable. It is an aggressive petroleum reduction strategy that is technically and economically feasible using existing and emerging technologies. This goal reflects ambitious but achievable levels of demand reduction through the combined effects of enhanced fleet fuel efficiency and use of alternative fuels.

What Options Could Be Used to Meet the Goal?

As illustrated in Figure 7, the staff has combined the following options that together can be an effective strategy to meet the petroleum reduction goal:

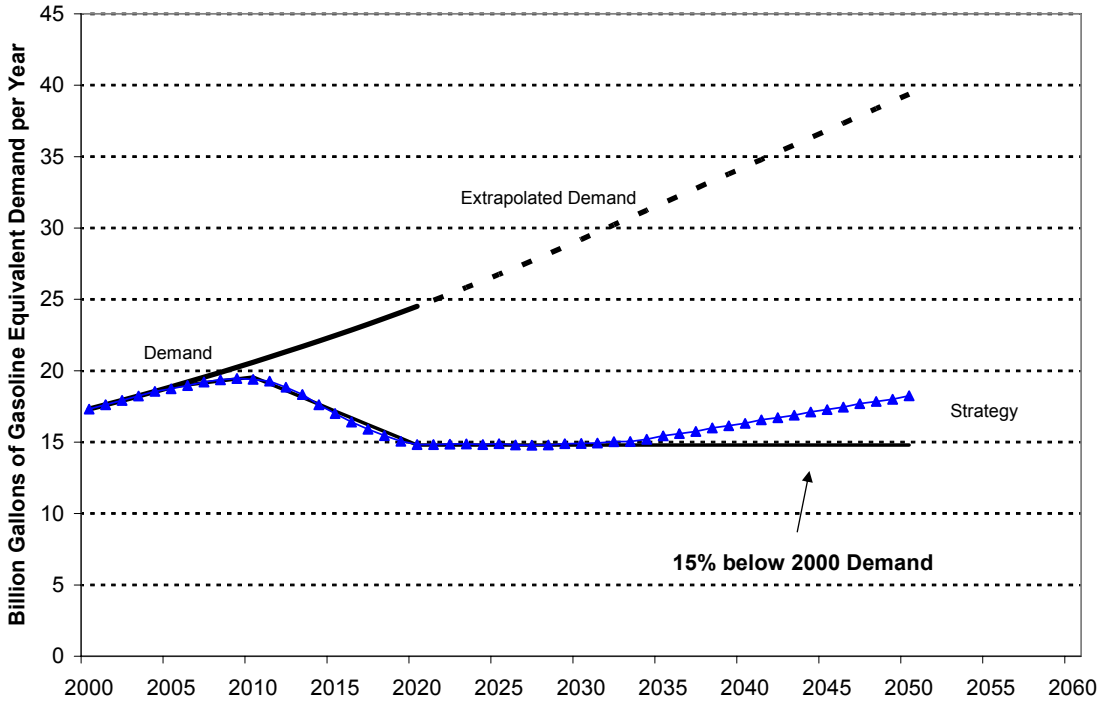
Near-Term Options

- Use more fuel efficient tires with proper inflation.
- Improve fuel economy in government fleets.
- Improve vehicle maintenance.
- Use natural gas-derived Fischer-Tropsch fuel as a 33 percent blending agent in diesel.

Mid- to Long-Term Options

- Add new light-duty vehicles with fuel economy of 40 miles per gallon.
- Introduce fuel cell light-duty vehicles in 2012, increasing to 10 percent of new vehicle sales by 2020, and 20 percent by 2030.

Figure 7
Strategy for Meeting the Petroleum Reduction Goal



As shown in Figure 7, this strategy meets the petroleum reduction goal through 2030. Beyond 2030, California's growth in population and vehicle use will overcome the reduced demand for petroleum fuels provided by this strategy. Additional use of alternative fuels and/or a further increase in vehicle efficiency will be needed to meet the recommended goal.

The options selected to meet the recommended goal are discussed below although the staff did not evaluate all possible options and combinations. A more detailed description of the fuel efficiency, fuel substitution, pricing and other options is contained in *Appendix C: Petroleum Reduction Options (Task 3).*

Near-Term Options. The following near-term options can be used to begin to decrease petroleum demand within the next few years:

1. Various Fuel Efficiency Options

   Several fuel efficiency options can be implemented fairly easily and quickly. These options include efficient tires, efficient government fleets, and improved vehicle maintenance. Although these near-term options can reduce demand by a small amount, and implementing these programs sets a positive leadership example, these options will not reduce demand enough to meet the established goal.

2. Fischer-Tropsch Diesel

   Fischer-Tropsch is a process to convert natural gas to a fuel that can be used in existing diesel engines. When blended 33 percent by volume into diesel fuel, this fuel can be less expensive than conventional California diesel and can be used directly in the existing retail fueling infrastructure. Fischer-Tropsch diesel is imported into California today and used in small quantities as a blending agent. Today, the major barrier to widespread use of Fischer-Tropsch diesel is its cost.

   At today's diesel prices, Fischer-Tropsch diesel costs about 10 cents more per gallon to produce, and retail prices are expected to be 15 to 25 cents per gallon higher than conventional diesel. However, to meet air quality goals, new federal and state fuel specifications are likely to increase the cost of conventional diesel. When compared to this higher-price conventional diesel, the incremental cost decreases to only 5 to 10 cents per gallon. Further, the lower aromatic content and higher cetane level of Fischer-Tropsch diesel make it attractive in California due to the California's more restrictive fuel quality specifications.

Mid- to Long-Term Options. Sustaining the recommended goal will require more aggressive actions than the near-term options listed above. The on-road fuel economy of cars and light trucks will need to be doubled, to 40 miles per gallon or more, to meet this goal. This can be achieved using existing technologies now available and by using emerging technologies such as hybrid electric drive and clean diesel engines.

Most alternative fuels are not cost competitive. With a few exceptions, alternative fuels require public support for wide-scale deployment, especially for fueling infrastructure. Continued technology development is needed to improve the economics for alternative fuel options. Over the longer term, alternative fuels, which are outside the bounds of "business as usual" for automobile companies and energy suppliers, should be pursued to protect California from the adverse consequences of tight supply, higher prices, and environmental concerns such as climate change.

1. Improving Light-Duty Vehicle Fuel Economy

   The average, on-road fuel economy of cars and light-duty trucks in California has increased from 12.6 miles per gallon in 1970 to today's average of about 20.7 mpg, as a result of federal CAFE standards. These standards were last increased in 1985, with only minor changes made in 1986 and 1989.

   Because the CAFE standards have been largely unchanged since 1985, most technological improvements to engines and vehicles have been used to increase performance and overcome gains in weight, rather than improve fuel economy. These weight gains have occurred as consumers purchased a growing number of trucks and SUVs instead of cars.

   National experts, such as the National Research Council of the National Academy of Sciences, and the American Council for an Energy Efficient Economy, have identified multiple pathways to achieve fleet average fuel economy of 30 to 45 mpg. The staff's analysis shows that, in most instances, increasing fuel economy creates consumer fuel savings that exceed the increased cost of the more fuel- efficient vehicle. In addition, society benefits from improvements to the environment and energy security.

   However, requiring vehicle manufacturers to improve fuel economy is the sole domain of the federal government. The challenge for California policy makers is to work effectively with federal government to improve new car fuel economy.

2. Hydrogen Fuel Cell Vehicles

   Hydrogen in fuel cell vehicles is one of the more promising long-term options. The advantages of direct hydrogen fuel cell vehicles include high efficiency, reduced climate change impacts, and zero emissions from the tailpipe. A primary disadvantage is the lack of an extensive hydrogen-fueling network. Other barriers must also be overcome, such as the high initial costs of the early prototype vehicles, fuel storage, and fueling infrastructure.

   California is a founding member of the California Fuel Cell Partnership, located in West Sacramento. This partnership of 29 members has been working for four years to begin the process of deploying fuel cell vehicles and establishing the necessary fueling infrastructure. The objective of the partnership is to pave the way for commercialization of hydrogen fueled vehicles.

   Following in the steps of California, President Bush has established several initiatives to advance fuel cell technology and fueling infrastructure. The National Fuel Cell Initiative would expend 1.2 billion dollars over 5 years on research and demonstration of hydrogen production, storage and distribution. The National Freedom Car Initiative aims to develop the technologies to enable the production of affordable fuel cell light-duty vehicles. The California Fuel Cell Partnership is

working closely with the federal agencies to coordinate efforts and advance their compatible goals.

These efforts are also designed to identify the need for policies to help remove barriers and accelerate the introduction of hydrogen fuel and vehicles.

Other Options. Other options to achieve the recommended petroleum reduction goal are possible. For example, use of natural gas in medium- and heavy-duty vehicles could be expanded. Natural gas provides positive direct net benefits at petroleum costs only slightly higher than assumed in the report. For the long term, however, the availability of supplies of natural gas for expanded transportation use may become uncertain in light of its need for other purposes such as power production and heating. Another option could be to expand the number of flexible fuel vehicles capable of operating on ethanol blends of gasoline. A blend of ethanol with low cost petroleum products could provide a fuel with positive direct net benefits.

What are the Recommendations?

Recommendation # 1. The Governor and Legislature should adopt the recommended statewide goal of reducing demand for on-road gasoline and diesel to 15 percent below the 2000 demand level by 2020 and maintain that level for the foreseeable future.

If the Governor and Legislature adopts this goal, it will provide a framework to guide California down the path to reduced petroleum consumption. Achieving the goal will reduce California's dependence on imported oil and petroleum production, moderate price volatility, improve environmental quality, and demonstrate a positive leadership example reducing greenhouse gas emissions.

Recommendation #2. The Governor and Legislature should work with the California delegation and other states to establish national fuel economy standards that double the fuel efficiency of new cars, light trucks and SUVs.

The most effective way to improve vehicle fuel economy is to revise the federal CAFE standards. In cooperation with other states, California could press the Congress to adopt new standards, which double the fuel economy of new vehicles.

Recommendation #3. The Governor and Legislature should establish a goal to increase the use of alternative fuels to 15 percent by 2020.

California should act to increase the use of alternative fuels as a strategy to reduce petroleum demand and to hedge against the costs and risks of a growing dependence on petroleum fuels. The Governor and Legislature should adopt a goal establishing a minimum fraction of on-road transportation fuel that is derived from non-petroleum sources. Consistent with the petroleum reduction goal of Recommendation #1, the staff recommends an additional goal of 15 percent use of alternative fuels by the year 2020.

To help sustain the efforts to increase alternative fuel use, the Energy Commission will establish a comprehensive plan to deploy the most attractive alternative fuels as part of its Integrated Energy Policy Report. The plan would focus on both near- and mid-term implementation, as well as identifying the steps needed to establish hydrogen as a long-term, sustainable fuel for the post-2020 timeframe.